What is intelligence?

- Most of us share the intuition that there are two ways a problem can be difficult:
  - Lack of information/knowledge
  - Need to
    - ignore some information
    - reason flexibly
    - think fast
    - come up with a novel solution

1

What is intelligence?

- We also may share the intuition that there are multiple domains in which individuals can have different abilities:
  - Spatial reasoning
  - Verbal reasoning
  - Quantitative reasoning

2

Early intelligence testing

Impetus: 1904 French universal education law

Goal: Identify children who would benefit more from special education than from the regular classes

3

Binet's approach

- Intelligence is not unitary or unchanging
  - reflects many processes
  - including reasoning and judgment
  - can't be measured on one scale, like height
- Empirical, limited approach to testing
  - Did the items help with the practical task of predicting which children would be held back in school?

Alfred Binet (1857-1911)

4

Binet's approach

- Designed age-appropriate tasks
  - e.g., at 2, fit shapes into correct holes
  - at 12, define 'government'
- Score = mental age

Alfred Binet (1857-1911)

5

Binet's approach

- Worried about ethics of broad testing
  - could create 'self-fulfilling prophecy'
- Developed 'mental orthopedics'
  - special educational assistance for children identified by his test as needing help

Alfred Binet (1857-1911)

6

Further developments: The concept of IQ

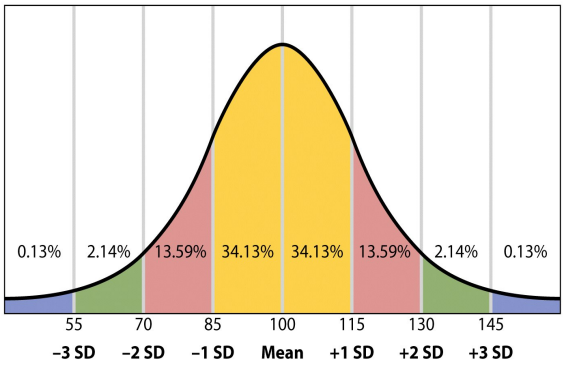
- Stern developed "Intelligence Quotient" (IQ)
  - Difficult to compare scores across ages
  - Noticed ratio of 'mental age' to chronological age tended to remain constant
  - IQ = 100 x $\frac{\text{Mental Age}}{\text{Chronological Age}}$
- Problem: growth rates aren't really constant
  - Mental age plateaus by adulthood

Wilhelm Stern (1871-1938)

7

IQs aren't IQs any more

Modern IQ – Deviation scores; How many of your age-mates did you outscore?



15% → IQ = 85

50% → IQ = 100

85% → IQ = 115

98% → IQ = 130

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Standard IQ tests

- "Stanford-Binet" test -- American revision of Binet's test that incorporated IQ
  - Overall IQ measure
  - Sub-scales: Verbal reasoning, Abstract/visual reasoning, Quantitative reasoning, Short-term memory
- Wechsler tests (WAIS-III & WISC-III)
  - Developed for adults & children
  - Now most widely used test

9

Standard IQ tests

WISC Verbal item types (e.g.):

Verbal arithmetic problems

What is a helicopter?

How are a hammer and a chisel alike?

Digit span: repeat these numbers in order when I'm finished

WISC Performance item types:

Children are shown a picture, such as a car with no wheels, and asked what's missing

Mazes: children draw a line through printed mazes

10

Theories of intelligence

- Interpretation and use of IQ scores have been driven by different views of what intelligence really is
  - Intelligence is mostly one thing -- single factor
  - Different aptitudes -- multiple factors

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Spearman's 'g': One factor view

- 'g' = general intelligence
- Basic evidence:
  - *different subtests are correlated with each other*
  - that is, an individual who does well on one tends to do well on another
  - Spearman took this as evidence of an underlying core cognitive ability common to many tasks

Charles Spearman (1863-1945)

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Multiple factors

- Thurstone:
  - Argued the shared correlation among different tests (g) was less impressive than the differences among *clusters of tests*
  - Multiple abilities
    - 7 "Primary mental abilities"

13

Thurstone's 7 primary mental abilities

- Verbal comprehension
- Word fluency
- Number
- Spatial visualization
- associative Memory
- perceptual Speed
- Reasoning

Is it more useful to think of intelligence is one thing (g)? Or as multiple PMA's?
Still very controversial:
- *different tests do tend be correlated*
- *but it's also true that sub-tests in the same domain are even more highly correlated*

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Crystalized vs. fluid intelligence

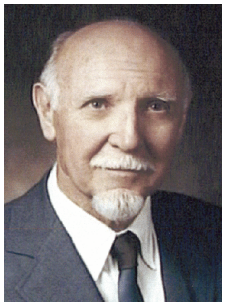
Raymond Cattell's 2-factor theory:

Crystalized intelligence (g-c)

- Acquired knowledge

e.g., verbal & numerical ability, historical facts, social conventions

- culturally based



Raymond B. Cattell (1905-1998)

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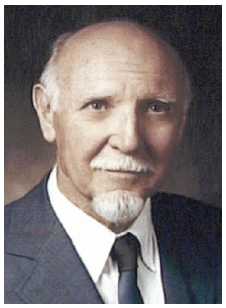
Crystalized vs. fluid intelligence

Raymond Cattell's 2-factor theory:

Fluid intelligence (g-f)

- On-the-spot reasoning ability

e.g., problem-solving, pattern recognition, ability to acquire novel concepts



Raymond B. Cattell (1905-1998)

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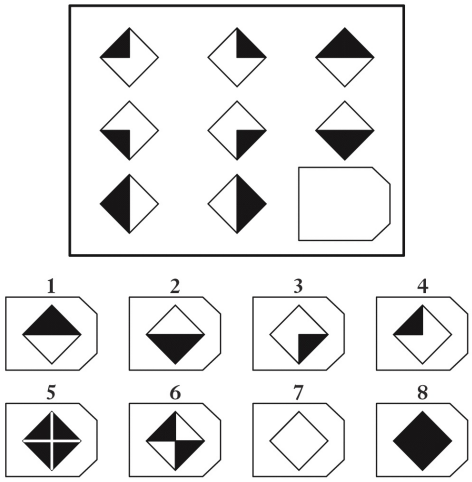
Raven's Progressive Matrices Test

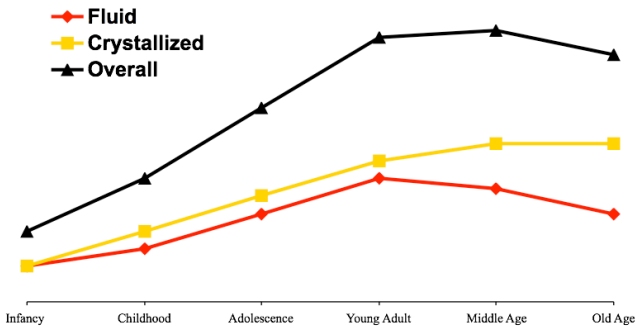
A test of Fluid intelligence



17

Support for Cattell's view

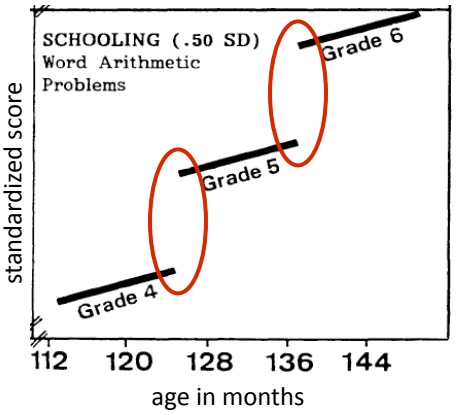
- Tests of fluid intelligence do not strongly correlate with tests of crystallized intelligence
- And *g-f* and *g-c* develop differently



18

IQ is not unchanging: Influences of schooling

(Cahan & Cahan, 1989)



- School cut-offs: Children only a little different in age can be in different grades in school
- Scores on IQ sub-tests increase with age AND schooling
  - Children who are the same age but in a higher grade score higher
- Schooling vs. age matter more vs. less for different sub-tests

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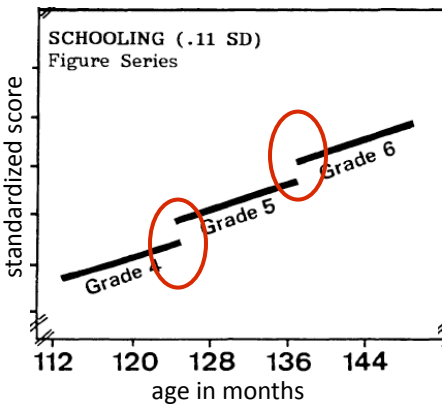
IQ is not unchanging: Influences of schooling

(Cahan & Cahan, 1989)



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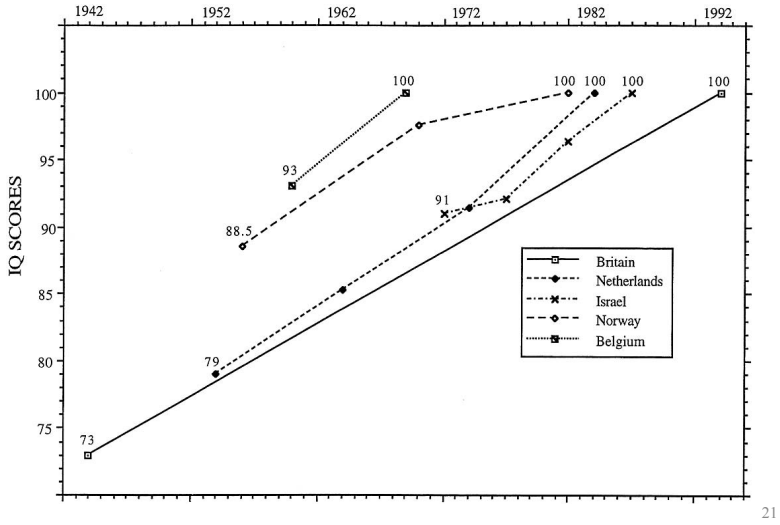
20

IQ also changes with generations: The Flynn effect



21

IQ also changes with generations: The Flynn effect

- Possible explanations?
  - Better nutrition
  - Changes in education, and access to education

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Is IQ useful?

- As a predictor of achievement ...?
  - Predicts school performance moderately well *(this was Binet's original goal*)
- Job performance outside of school?
  - IQ predicts better on-the-job evaluations during training
  - Not as predictive once experienced
  - Predictive strength depends on the nature of the job

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IQ is not the only predictor of success

- or even the strongest
- "self-discipline" is a better predictor of grades in high school than IQ (Duckworth & Seligman, 2005)
  - and predicts college grades better than SAT scores (Wolfe & Johnson, 1995)
  - *you'll hear more about achievement motivation, delay of gratification, etc., later in the semester!!*

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Cultural effects on IQ

- Why we can't simply compare test scores across different social or cultural groups

25

Cultural effects on IQ

Example:

- There are more men than women in the higher reaches of the math, engineering, and science fields.
- Some argue this is primarily because
  - fewer women have the highest aptitude in these fields
  - & these sex differences are genetic: women and girls are intrinsically less able in these fields

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Cultural effects on IQ

Liz Spelke

But aren't there other explanations?

- Women & men's performance on tests does show subtly different profiles
  - verbal fluency vs. verbal analogies
  - arithmetic calculation vs. math word problems
  - memory for spatial location vs. geometric configuration of an environment
- But these differences are very small (big overlap in distributions; Hyde, 2005)

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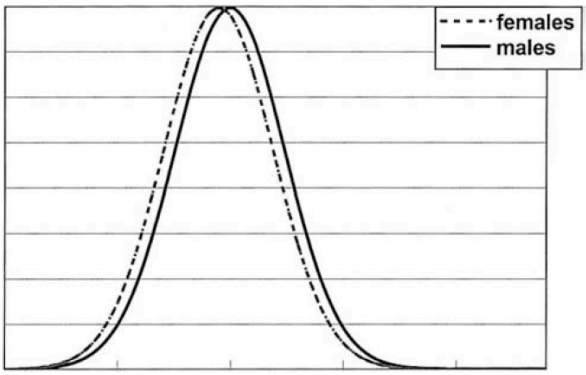
Figure 1

Graphic Representation of a 0.21 Effect Size



Note. Two normal distributions that are 0.21 standard deviations apart (i.e., $d = 0.21$). This is the approximate magnitude of the gender difference in self-esteem, averaged over all samples, found by Kling et al. (1999). From "Gender Differences in Self-Esteem: A Meta-Analysis," by K. C. Kling, J. S. Hyde, C. J. Showers, and B. N. Buswell, 1999, *Psychological Bulletin, 125,* p. 484. Copyright 1999 by the American Psychological Association.

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Cultural effects on IQ


Liz Spelke

But aren't there other explanations?

- Women & men's performance on tests does show subtly different profiles
  - verbal fluency vs. verbal analogies
  - arithmetic calculation vs. math word problems
  - memory for spatial location vs. geometric configuration of an environment
- And these differences arise *late in development*
  - makes it difficult to separate intrinsic factors from social/cultural factors that also affect development

29

A classic experiment

Rosenthal & Jacobson, 1966

- Nonverbal intelligence test was administered to all children in an elementary school
- Test described to teachers as "designed to predict academic 'blooming' or intellectual gain"

Key Manipulation:

- Each teacher was told that some particular students (about 20%) "would show unusual intellectual gains during the academic year", based on the results of the test.
  - These students had really been chosen randomly.

30

A classic experiment

Rosenthal & Jacobson, 1966

- Eight months later, the intelligence test was administered again.
- What happened? What do you think?

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Self-fulfilling prophecy

Rosenthal & Jacobson, 1966

Table 1. Mean Gains in IQ

Grade	Controls		Experimentals		Diff.
	M	σ	M	σ	
1	12.0	16.6	27.4	12.5	15.4
2	7.0	10.0	16.5	18.6	9.5
3	5.0	11.9	5.0	9.3	0.0
4	2.2	13.4	5.6	11.0	3.4
5	17.5	13.1	17.4	17.8	-0.1
6	10.7	10.0	10.0	6.5	-0.7
Weighted *M*	8.4*	13.5	12.2**	15.0	3.8

* Mean number of children per grade = 42.5

** Mean number of children per grade = 10.8

32

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Why the age effect?

1) Younger children might be more susceptible to expectations communicated by the teacher.

2) Younger children have less well-established reputations, so the information fed to the teachers is more credible.

33

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Rosenthal & Jacobson, 1966

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How are teachers' expectations communicated?

Which of these behaviors actually influence children? How?

34

Some ideas:

Table 4
Summary of Four Factors in the Mediation of Teacher Expectancy Effects

Factor	Brief summary of the evidence
Central factors	
Climate (affect)	Teachers appear to create a warmer socioemotional climate for their special students. This warmth appears to be at least partially communicated by nonverbal cues.
Input (effort)	Teachers appear to teach more material and more difficult material to their special students.
Additional Factors	
Output	Teachers appear to give their special students greater opportunities for responding. These opportunities are offered both verbally and nonverbally (e.g., giving a student more time in which to answer a teacher's question).
Feedback	Teachers appear to give their special students more differentiated feedback, both verbal and nonverbal, as to how these students have been performing.

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Implications for thinking about intelligence testing?

- Especially about interpreting differences between cultural groups as intrinisic differences in ability

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A cultural influence on intellectual development: Stereotypes

Stereotypes – society-wide beliefs about certain social groups as a whole (wide individual variation is ignored)

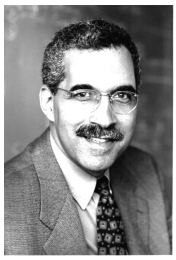
A prevalent negative stereotype:

- Women aren't good at math and science.

37

A cultural influence on intellectual development: Stereotypes

- Stereotypes can turn into self-fulfilling prophecies by impairing performance: Stereotype threat



Claude Steele

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A cultural influence on intellectual development: Stereotypes

- Stereotypes can turn into self-fulfilling prophecies by impairing performance:

If we are in a situation for which a negative stereotype about our group applies, we fear the prospect of being treated stereotypically, or (worse) conforming to the stereotype.

- Fear of being reduced to a stereotype (*stereotype threat*) can impair performance.
- Impaired performance confirms the stereotype!
- If stereotype threat is chronic, it can lead to *disidentification* with the academic domain.

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Women in math

Spencer, Steele, & Quinn (1999)

Participants: male and female college students, equally good at math (based on grades and SATs) and interested in math

Task: difficult questions from math GRE

Key Manipulation:

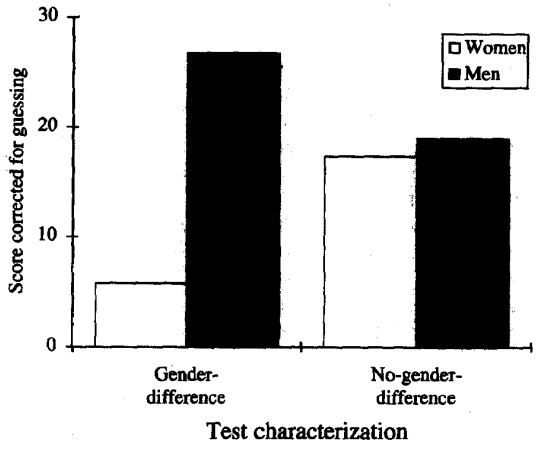
- Half were told that the test had never revealed gender differences in the past.
- Half were told that the test had shown gender differences in the past.

40

Women in math

Spencer, Steele, & Quinn (1999)

Figure 1
Mean Performance on a Difficult Math Test as a Function of Gender and Test Characterization



41

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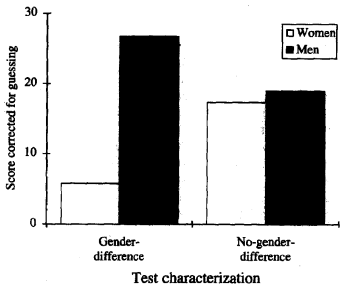

When stereotype was not a threat (the No-gender-difference condition), women did as well as men

-- as we would expect based on their matched grades & SATs!

Many similar results involving other stereotypes, other groups

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Are children susceptible to stereotype threat?
Ambady et al., 2001

- Previous results with adults:
  - Asian-American women did better on a math test following an ethnic-identity prime
  - ... and worse following a gender-identity prime
- What should we expect in school children?
  - As early as 1st grade, children believe boys are better at math than girls
  - *Though gender differences in math ability do not appear until adolescence (Hyde et al., 1990)*

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Are children susceptible to stereotype threat?
Ambady et al., 2001

Participants: Asian-American girls, K to 8th grade

Task: Standardized math test (Iowa test of basic skills)

Manipulation:

- ethnic identity prime:
  - K-2nd: color in a picture of children eating rice from a bowl with chopsticks
  - 3rd-8th: questionnaire related to ethnicity

44

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Ambady et al., 2001

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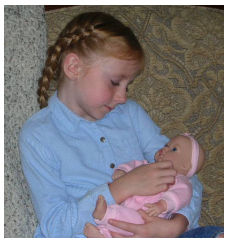
  - K-2nd: color in a picture of girl holding a doll
  - 3rd-8th: questionnaire related to gender



45

Are children susceptible to stereotype threat?
Ambady et al., 2001

Participants: Asian-American girls, K to 8th grade

Task: Standardized math test (Iowa test of basic skills)

Manipulation:

- control prime condition:
  - K-2nd: color a landscape scene
  - 3rd-8th: questionnaire unrelated to gender or ethnicity

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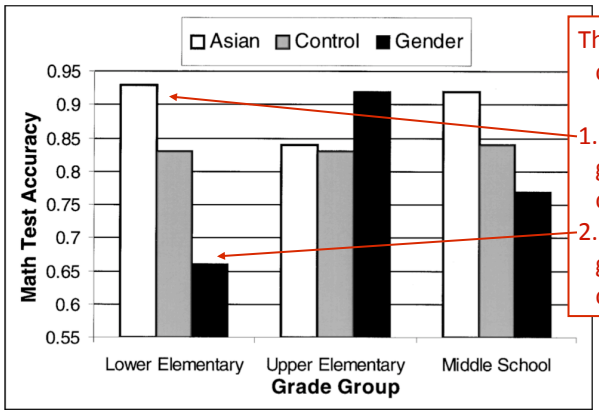
Results: Ambady et al., 2001



The primes influenced children's performance:

1. Priming ethnicity made girls score higher than controls
2. Priming gender made girls score lower than controls

Fig. 1. Performance of Asian-American girls on the math test. Accuracy is graphed separately for the three grade groups and the three identity-activation conditions.

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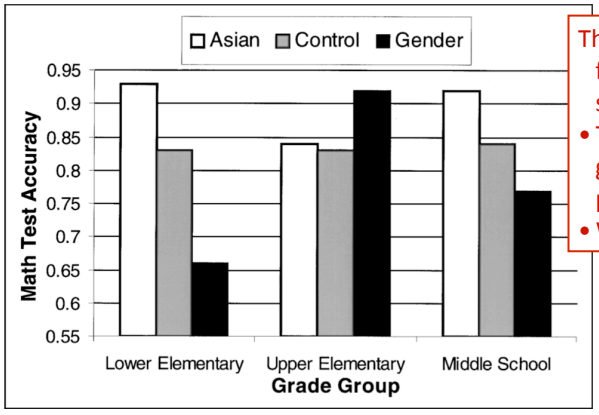
Results: Ambady et al., 2001



These results didn't hold for the upper elementary school girls (grade 3-5).

- They did best when gender identity was primed.
- Why?

Fig. 1. Performance of Asian-American girls on the math test. Accuracy is graphed separately for the three grade groups and the three identity-activation conditions.

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Implications for thinking about intelligence testing?

- Especially about differences between groups!
  - Performance on tests varies across contexts
  - Can be pushed around by subtle activation of culturally entrenched stereotypes

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Summary

- Intelligence tests can be useful for practical purposes
- There are many theories of what is the most useful way to think about intelligence:
  - Single factor -- 'g'
  - Two factors -- g-c, g-f
  - Multiple intelligences
- Academic achievement can be predicted by IQ
- But achievement depends on many other factors
  - Including subtle (or not-so-subtle) signs of what others expect from us

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